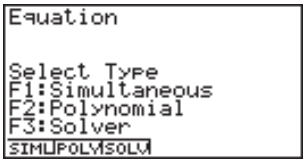
Chapter 4

Equation Calculations

Your graphic calculator can perform the following three types of calculations:

- Simultaneous linear equations
- High degree equations
- Solve calculations

From the Main Menu, enter the EQUA Mode.



- {**SIML**} ... {linear equation with 2 to 30 unknowns}
- {**POLY**} ... {degree 2 to 30 equations}
- {**SOLV**} ... {solve calculation}

4-1 Simultaneous Linear Equations

4-2 High Degree Equations

4-3 Solve Calculations

4-4 What to Do When an Error Occurs

4-1 Simultaneous Linear Equations

Description

You can solve simultaneous linear equation with two to 30 unknowns.

- Simultaneous Linear Equation with Two Unknowns:

$$a_1x_1 + b_1x_2 = c_1$$
$$a_2x_1 + b_2x_2 = c_2$$

- Simultaneous Linear Equation with Three Unknowns:

$$a_1x_1 + b_1x_2 + c_1x_3 = d_1$$
$$a_2x_1 + b_2x_2 + c_2x_3 = d_2$$
$$a_3x_1 + b_3x_2 + c_3x_3 = d_3$$
$$\vdots$$

Set Up

1. From the Main Menu, enter the EQUA Mode.

Execution

2. Select the SIML (simultaneous equation) Mode, and specify the number of unknowns (variables).
   You can specify from 2 to 30 unknowns. To specify more than six unknowns, press F6(*n*) and then input a value.
3. Sequentially input the coefficients.

   The cell that is currently selected for input is highlighted. Each time you input a coefficient the highlighting shifts in the sequence:

   $a_1 \rightarrow b_1 \rightarrow c_1 \rightarrow \ldots a_n \rightarrow b_n \rightarrow c_n \rightarrow$ (n = 2 to 30)

   You can also input fractions, complex numbers, and values assigned to variables as coefficients.

   You can cancel the value you are inputting for the current coefficient by pressing ESC at any time before you press EXE to store the coefficient value. This returns to the coefficient to what it was before you input anything. You can then input another value if you want.
   To change the value of a coefficient that you already stored by pressing EXE, move the cursor to the coefficient you want to edit. Next, input the value you want to change to or press F1(EDIT).

   Pressing F3(CLR) clears all coefficients to zero.
4. Solve the equations.

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Example **To solve the following simultaneous linear equations for x, y, and z**

$$\begin{aligned} 4x + y - 2z &= -1 \\ x + 6y + 3z &= 1 \\ -5x + 4y + z &= -7 \end{aligned}$$

Procedure

① MENU EQUA

② F1(SIML)

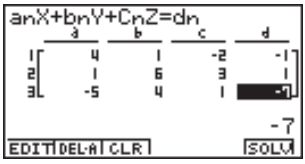
F2(3)

③ 4 EXE 1 EXE (↔) 2 EXE (↔) 1 EXE

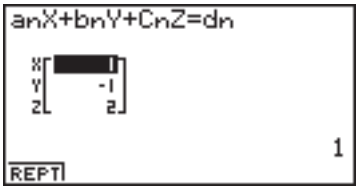
1 EXE 6 EXE 3 EXE 1 EXE

(↔) 5 EXE 4 EXE 1 EXE (↔) 7 EXE

④ F6(SOLV)



Result Screen



Internal calculations are performed using a 15-digit mantissa, but results are displayed using a 10-digit mantissa and a 2-digit exponent.

Simultaneous linear equations are solved by inverting the matrix containing the coefficients of the equations. For example, the following shows the solution (x_1, x_2, x_3) of a simultaneous linear equation with three unknowns.

$$\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{bmatrix}^{-1} \begin{bmatrix} d_1 \\ d_2 \\ d_3 \end{bmatrix}$$

Because of this, precision is reduced as the value of the determinant approaches zero. Also, simultaneous equations with three or more unknowns may take a very long time to solve.

An error occurs if the calculator is unable to find a solution.

After calculation is complete, you can press F1 (REPT), change coefficient values, and then re-calculate.

4-2 High Degree Equations

Description

You can use this calculator to solve high degree equations such as quadratic equations and cubic equations.

- Quadratic Equation:
  $ax^2 + bx + c = 0\ (a \neq 0)$
- Cubic Equation:
  $ax^3 + bx^2 + cx + d = 0 (a \neq 0)$
  ⋮

Set Up

1. From the Main Menu, enter the EQUA Mode.

Execution

2. Select the POLY (high degree equation) Mode, and specify the degree of the equation. You can specify a degree from 2 to 30. To specify a degree greater than three, press F3 (*n*) and then input a value.
3. Sequentially input the coefficients.

   The cell that is currently selected for input is highlighted. Each time you input a coefficient the highlighting shifts in the sequence:

   $a \rightarrow b \rightarrow c \rightarrow \ldots$

   You can also input fractions, complex numbers, and values assigned to variables as coefficients.

   You can cancel the value you are inputting for the current coefficient by pressing ESC at any time before you press EXE to store the coefficient value. This returns to the coefficient to what it was before you input anything. You can then input another value if you want.
   To change the value of a coefficient that you already stored by pressing EXE, move the cursor to the coefficient you want to edit. Next, input the value you want to change to or press F1 (EDIT).

   Pressing F3 (CLR) clears all coefficients to zero.
4. Solve the equations.

Internal calculations are performed using a 15-digit mantissa, but results are displayed using a 10-digit mantissa and a 2-digit exponent.
Equations of third degree or higher may take a very long time to solve.
An error occurs if the calculator is unable to find a solution.
After calculation is complete, you can press F1 (REPT), change coefficient values, and then re-calculate.

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Example **To solve the cubic equation**

$x^3 - 2x^2 - x + 2 = 0$

Procedure

① MENU EQUA

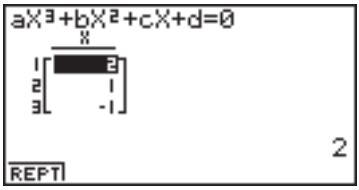
② F2(POLY)

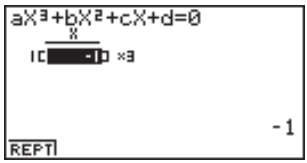
F2(3)

③ 1 EXE (−) 2 EXE (−) 1 EXE 2 EXE

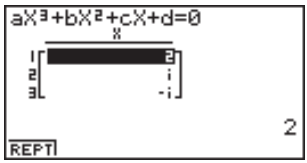
④ F6(SOLV)

Result Screen





(Multiple Solutions)



(Complex Number Solution)

4-3 Solve Calculations

Description

The Solve Calculation Mode lets you determine the value of any variable in a formula, without going through the trouble of solving the equation.

Set Up

1. From the Main Menu, enter the EQUA Mode.

Execution

2. Select the SOLV (Solve) Mode, and input the equation as it is written.
   If you do not input an equals sign, the calculator assumes that the expression is to the left of the equals sign, and there is a zero to the right. *1
3. In the table of variables that appears on the display, input values for each variable.
   You can also specify values for Upper and Lower to define the upper and lower limits of the range of solutions. *2
4. Select the variable for which you want to solve to obtain the solution.
   "Lft" and "Rgt" indicate the left and right sides that are calculated using the solution.*3

*1 An error occurs if you input more than one equals sign.
*2 An error occurs if the solution falls outside the range you specify.
*3 Solutions are approximated using Newton's method. Lft and Rgt values are displayed for confirmation, because Newton's method may produce results that are the real solution. The closer the difference between the Lft and Rgt values is to zero, the lower degree of error in the result.
The message "Retry" appears on the display when the calculator judges that convergence is not sufficient for the displayed results.

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Example **An object thrown into the air at initial velocity V takes time T to reach height H. Use the following formula to solve for initial velocity V when H = 14 (meters), T = 2 (seconds) and gravitational acceleration is G = 9.8 (m/s²).**

$H = VT - 1/2\ GT^2$

Procedure

① MENU EQUA

② F3(SOLV)

ALPHA x^2(H) SHIFT ·(=) ALPHA 2(V) ALPHA ÷(T) − (1 ÷ 2)

ALPHA $a\frac{b}{c}$(G) ALPHA ÷(T) x^2 EXE

③ 1 4 EXE(H = 14)

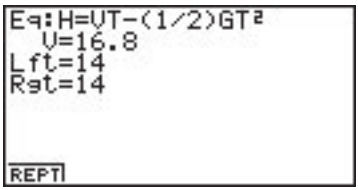
0 EXE(V = 0)

2 EXE(T = 2)

9 · 8 EXE(G = 9.8)

④ Press ▲ to highlight V = 0, and then press F6(SOLV).

Result Screen



4-4 What to Do When an Error Occurs

• Error during coefficient value input

Press the [ESC] key to clear the error and return to the value that was registered for the coefficient before you input the value that generated the error. Try inputting a new value again.

• Error during calculation

Press the [ESC] key to clear the error and display coefficient. Try inputting values for the coefficients again.

■ Clearing Equation Memories

1. Enter the equation calculation mode (SIML or POLY) you want to use and perform the function key operation required for that mode.
   - In the case of the SIML Mode ([F1]), use number keys to specify the number of unknowns.
   - In the case of the POLY Mode ([F2]), use number keys to specify the degree of the polynomial.
   - If you pressed [F3] (SOLV), advance directly to step 2.
2. Press [F2] (DEL•A).
3. Press [EXE] (Yes) to delete the applicable equation memories or [ESC] (No) to abort the operation without deleting anything.